School District of Marshfield Course Syllabus

Course Name: Chemistry Honors
Length of Course: Year
Credit: 1 Credit

Program Goal:

The School District of Marshfield K-12 Science Program will prepare and motivate learners to explore, problem solve and collaborate with their classmates to interpret science and explain the world around them. Learners will acquire knowledge and evidence that promotes creative solutions through the evaluation and understanding of scientific theories and evidence. Learners will collect, analyze and reason with scientific data through investigations that ultimately allow for the generation of scientific explanations. Critical thinking skills will elevate natural curiosity, make sense of scientific data and promote scientific literate citizens.

Course Description:

Chemistry is the study of the structure and composition of matter that makes up living things and their environment. Chemistry deals with the study of the changes of matter and the mechanisms by which changes occur. Energy and its transformations through systems and reactions will be investigated. How atoms bond and how this describes the chemical and physical properties of materials will also be a focus of study. This course is recommended for college-bound students. Students will be expected to perform labs almost weekly utilizing a laboratory notebook.

Wisconsin Standards for Science (SCI)	
Crosscutting Concepts (CC)	
CC1: Students use science and engineering practices, disciplinary core ideas, and ***patterns*** to make sense of phenomena and solve problems.	
Patterns	CC1.h: Students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena. They recognize classifications or explanations used at one scale may not be useful or need revision using a different scale, thus requiring improved investigations and experiments. They use mathematical representations to identify and analyze patterns of performance in order to reengineer a designed system.
CC2: Students use science and engineering practices, disciplinary core ideas, and ***cause and effect*** relationships to make sense of phenomena and solve problems.	
Cause and Effect	CC2.h: Students understand empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects. They suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems. They also propose causal relationships by examining what is known about smaller scale mechanisms within the system. They recognize changes in systems may have various causes that may not have equal effects.
CC4: Students use science and engineering practices, disciplinary core ideas, and an understanding of ***systems and models*** to make sense of phenomena and solve problems.	
Systems and System Models	CC4.h: Students investigate or analyze a system by defining its boundaries and initial conditions, as well as its inputs and outputs. They use models (e.g., physical, mathematical, computer models) to simulate the flow of energy, matter, and interactions within and between systems at different scales. They also use models and simulations to predict the behavior of a system, and recognize that these predictions have limited precision and reliability due to the assumptions and approximations inherent in the models. They also design systems to do specific tasks.
CC5: Students use science and engineering practices, disciplinary core ideas, and an understanding of ***energy and matter*** to make sense of phenomena and solve problems.	

Energy and Matter	CC5.h: Students understand that the total amount of energy and matter in closed systems is conserved. They describe changes of energy and matter in a system in terms of energy and matter flows into, out of, and within that system. They also learn that energy cannot be created or destroyed. It only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
CC6: Students use science and engineering practices, disciplinary core ideas, and an understanding of ***structure and function*** to make sense of phenomena and solve problems.	
Structure and Function	CC6.h: Students investigate systems by examining the properties of different materials, the structures of different components, and their interconnections to reveal the systems' function and solve a problem. They infer the functions and properties of natural and designed objects and systems from their overall structure, the way their components are shaped and used, and the molecular substructures of their various materials.
CC7: Students use science and engineering practices, disciplinary core ideas, and an understanding of ***stability and change*** to make sense of phenomena and solve problems.	
Stability and Change	CC7.h: Students understand much of science deals with constructing explanations of how things change and how they remain stable. They quantify and model changes in systems over very short or very long periods of time. They see some changes are irreversible, and negative feedback can stabilize a system, while positive feedback can destabilize it. They recognize systems can be designed for greater or lesser stability.
Science and Engineering Practices (SEP)	
SEP1: Students ***ask questions and define problems***, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.	
Asking Questions SEP1.A	SEP1.A.h: Students ask questions to formulate, refine, and evaluate empirically testable questions. This includes the following: Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and seek additional information. Ask questions that arise from examining models or theories to clarify and seek additional information and relationships.

	Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables. Ask questions to clarify and refine a model or an explanation. Evaluate a question to determine if it is testable and relevant. Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory. Ask and evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of the design.
SEP2: Students ***develop and use models***, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.	
Developing Models SEP2.A	SEP2.A.h: Students use, synthesize, and develop models to predict and show relationships among variables and between systems and their components in the natural and designed world. This includes the following: Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence or design criteria. Design a test of a model to ascertain its reliability. Develop, revise, and use models based on evidence to illustrate and predict the relationships between systems of between components of a system. Develop and use multiple types of models to provide mechanistic accounts and predict phenomena. Move flexibly between these model types based on merits and limitations. Develop a complex model that allows for manipulation and testing of a proposed process or system. Develop and use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and solve problems.

SEP3: Students ***plan and carry out investigations***, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.	
Planning and Conducting Investigations SEP3.A	SEP3.A.h: Students plan and carry out investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models: This includes the following: Individually and collaboratively plan an investigation or test a design to produce data that can serve as evidence to build and revise models, support explanations for phenomena, and refine solutions to problems. Consider possible variables or effects and evaluate the investigation's design to ensure variables are controlled. Individually and collaboratively plan and conduct an investigation to produce data to serve as the basis for evidence. In the design: decide on types, how much, and accuracy of data needed to produce reliable measurements. Consider limitations on the precision of the data (e.g., number of trials, cost, risk, time) and refine the design accordingly. Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts. Select appropriate tools to collect, record, analyze, and evaluate data. Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated. Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points, or to improve performance relative to criteria for success.
SEP4: Students ***analyze and interpret data***, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.	
Analyze and Interpret Data SEP4.A	SEP4.A.h: Students engage in more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. This includes the following: Analyze data using tools, technologies, and models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

	Apply concepts of statistics and probability to scientific and engineering questions and problems, using digital tools when feasible. Concepts should include determining the fit of functions, slope, and intercepts to data, along with correlation coefficients when the data is linear. Consider and address more sophisticated limitations of data analysis (e.g., sample selection) when analyzing and interpreting data. Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations. Evaluate the impact of new data on a working explanation or model of a proposed process or system. Analyze data to optimize design features or characteristics of system components relative to criteria for success.
SEP5: Students ***mathematics and computational thinking***, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.	
Qualitative and Quantitative Data SEP5.A	SEP5.A.h: Students use algebraic thinking and analysis, a range of linear and nonlinear functions (including trigonometric functions, exponentials, and logarithms), and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. This includes the following: Decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success. Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system. Use mathematical, computational, and algorithmic representations of phenomena or design solutions to describe and support claims and explanations. Apply techniques of algebra and functions to represent and solve scientific and engineering problems. Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model “makes sense” by comparing the outcomes with what is known about the real world.

	Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m^3, acre-feet, and others).
SEP6: Students ***construct explanations and design solutions***, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.	
Construct an Explanation SEP6.A	SEP6.A.h: Students create explanations that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. This includes the following: Make quantitative and qualitative claims regarding the relationship between dependent and independent variables. Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources, including students' own investigations, models, theories, simulations, and peer review. Explanations should reflect the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. Apply scientific ideas, principles, and evidence to provide an explanation of phenomena taking into account possible, unanticipated effects.
SEP7: Students ***engage in argument from evidence***, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.	
Argue from Evidence SEP7.A	SEP7.A.h: Students use appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world. Arguments may also come from current scientific or historical episodes in science. This includes the following: Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues. Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. Respectfully provide and receive critiques on scientific arguments by probing reasoning and evidence, by

	challenging ideas and conclusions, by responding thoughtfully to diverse perspectives, and by determining what additional information is required to resolve contradictions. Construct, use, and present oral and written arguments or counterarguments based on data and evidence. Make and defend a claim based on evidence about the natural world or the effectiveness of a design solutions that reflects scientific knowledge and student-generated evidence. Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments. Consider relevant factors (e.g. economic, societal, environmental, and ethical considerations).
SEP8: Students ***will obtain, evaluate and communicate***, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.	
Obtain, Evaluate, and Communicate Information SEP8.A	SEP8.A.h: Students evaluate the validity and reliability of claims, methods, and designs. This includes the following: Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions, and to obtain scientific and technical information. Summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. Compare, integrate, and evaluate sources of information presents in different media or formats (e.g., visually, quantitatively, or text-based) in order to address a scientific question or solve a problem. Gather, read, and evaluate scientific and technical information from multiple authoritative sources, assessing the evidence and usefulness of each source. Synthesize and evaluate the validity and reliability of multiple claims, methods, or designs that appear in scientific and technical texts or media reports. Verify the data when possible. Communicate scientific and technical information in multiple formats, including orally, graphically, textually, and mathematically. Examples of information could include ideas about phenomena or the design and performance of a proposed process or system.

Physical Science (PS)	
PS1: Students use science and engineering practices, crosscutting concepts, and an understanding of ***matter and its interactions*** to make sense of phenomena and solve problems.	
Structures and Properties of Matter PS1.A	PS1.A.h: The sub-atomic structural model and interactions between electric charges at the atomic scale can be used to explain the structure and interactions of matter, including chemical reactions and nuclear processes. Repeating patterns of the periodic table reflect patterns of outer electrons. A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy to take molecule apart.
Chemical Reactions PS1.B	PS1.B.h: Chemical processes are understood in terms of collisions of molecules, rearrangement of atoms, and changes in energy as determined by properties of elements involved.
Nuclear Processes PS1.C	PS1.C.h: Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy.
Example Three-Dimensional Performance Indicators PS1	HS-PS1-1: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. HS-PS1-2: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. HS-PS1-3: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. HS-PS1-7: Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during chemical reaction.
PS4: Students use science and engineering practices, crosscutting concepts, and an understanding of ***waves and their applications in technologies for information transfer*** to make sense of phenomena and solve problems.	
Wave Properties PS4.A	PS4.A.h: The wavelength and frequency of a wave are related to one another by the speed of the wave, which depends on the type of wave and the medium through which it is passing. Waves can be used to transmit information and energy.
Electromagnetic Radiation PS4.B	PS4.B.h: Both an electromagnetic wave model and a photon model explain features of electromagnetic radiation broadly and describe common applications of electromagnetic radiation.
Example Three-Dimensional Performance Indicators PS4	HS-PS4-1: Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

Key Vocabulary:			
Controls	Isotopes	Atomic number	Atomic mass
Nuclear decay	Periodicity	Atomic radius	Ionization energy
Electronegativity	Coulombic attraction	Ionic bond	Metallic bond
Polar/nonpolar covalent bond	Law of Multiple Proportions	Law of Conservation of Matter	Law of Definite Composition
Percent composition	Moles	Molar mass	Stoichiometry
Limiting reactant	Percent yield	Intermolecular forces	Interparticle forces
Saturated solutions	Solute	Solvent	Concentration
Ideal gases	Vapor pressure	Precipitate	Neutralization
Exothermic reaction	Endothermic reaction	Chemical changes	Chemical properties
Physical changes	Physical properties	Independent variables	Dependent variables

Topics/Content Outline- Units and Themes:

Quarter 1:

- **Introduction to Chemistry, Matter, Property and Chemical Change**
    - Law of Conservation of Mass
    - Physical and Chemical Changes
    - Lab Equipment and Safety
    - SI Units and Conversions
    - Dimensional Analysis
    - Scientific Notation
    - Significant Digits
- **Atomic Structure**
    - Subatomic Particles
    - Isotopes and Nuclear Decay
    - Electron Configuration
    - Quantum Mechanics

Quarter 2:

- **The Periodic Table**
    - Periodicity
    - Periodic and Group Trends
    - Coulombic Attraction
- **Bonding**
    - Ionic Bonding
    - Metallic Bonding
    - Covalent Bonding

- **Chemical Reactions**
  - Balancing Equations
  - Types of Reactions
  - Predicting Products

Quarter 3:

- **The Mole**
  - Molar Mass
  - Mole Conversions
  - Empirical/Molecular Formulas
  - Hydrates
- **Stoichiometry**
  - 2 weeks
  - Stoichiometric Conversions
  - Limiting Reactants
  - Percent Yield
- **KMT**
  - Kinetic Molecular Theory
  - Intermolecular Forces
  - Phase Changes
  - Phase Diagrams

Quarter 4:

- **Gases and Gas Laws**
  - Gas Properties
  - Gas Laws (Boyles, Charles, Guy Lussac)
  - Combined Gas Law
  - Ideal Gas Law
  - Real versus Ideal Gases
- **Solutions**
  - Solubility Curves
  - Concentration of Solutions
  - Net Ionic Equations

Primary Resource(s):

Chemistry – The Central Science, 14th Edition
Pearson
ISBN: 978-01344-14-232
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